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## WHAT IS CLAIMED IS:

1. A compound comprising a  $\beta$ -substituted calix[n]pyrrole macrocycle having structure **I**:

R<sub>14</sub> **R**16 R<sub>17</sub><sub>R<sub>19</sub></sub> R<sub>1</sub>15 R<sub>12</sub> R<sub>13</sub> R<sub>20</sub> N' R<sub>D</sub> R<sub>10</sub> RÉ p R<sub>C</sub> R<sub>21</sub> R<sub>11</sub> R<sub>23</sub> Rg R<sub>22</sub> R<sub>8</sub> N-RB R<sub>F</sub>-N R<sub>24</sub> R<sub>6</sub> R<sub>7</sub> RĢ R<sub>25</sub> Ŕ5 Ŗн  $R_4$ R<sub>26</sub>  $\dot{R}_2$ Ŕ3 R<sub>1</sub> R<sub>28</sub> R<sub>30</sub> Ŕ<sub>32</sub> S

wherein n is 4, 5, 6, 7, or 8; and

when n is 4; p = q = r = s = 0, even numbered R substituents are fluoro, chloro, or bromo, odd numbered R substituents are independently as listed in paragraph i) below, and  $R_A - R_D$  are independently substituents as listed in paragraph ii) below;

when n is 5; p = 1, q = r = s = 0, even numbered R substituents are fluoro, chloro, or bromo, odd numbered R substituents are independently as listed in paragraph

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- i) below, and R<sub>A</sub> R<sub>E</sub> are independently substituents as listed in paragraph
  ii) below;
- when n is 6; p = q = 1, r = s = 0, even numbered R substituents are fluoro, chloro, or bromo, odd numbered R substituents are independently as listed in paragraph i) below, and  $R_A R_F$  are independently substituents as listed in paragraph ii) below;
- when n is 7; p = q = r = 1, s = 0, even numbered R substituents are fluoro, chloro, or bromo, odd numbered R substituents are independently as listed in paragraph i) below, and  $R_A$   $R_G$  are independently substituents as listed in paragraph ii) below;
- when n is 8; p = q = r = s = 1, even numbered R substituents are fluoro, chloro, or bromo, odd numbered R substituents are independently as listed in paragraph i) below, and  $R_A$   $R_H$  are independently substituents as listed in paragraph ii) below;
- i) alkyl, alkenyl, alkynyl, aryl, alkylaryl, formyl, acyl, hydroxyalkyl, hydroxyalkoxy, hydroxyalkenyl, hydroxyalkynyl, saccharide, carboxy, carboxyalkyl, carboxyamide, carboxyamidealkyl, alkyl sulfoxide, alkyl sulfone, alkyl sulfide, tetrahydropyran, tetrahydrothiapyran, thioalkyl, haloalkyl, haloalkenyl, haloalkynyl, alkyl ester, a site-directing molecule, a catalytic group, a reporter group, a binding agent, or a couple that is coupled to a site-directing molecule, to a catalytic group, to a reporter group, or to a binding agent;
- ii) hydrogen, alkyl, aminoalkyl, alkylsulfone, carboxy alkyl, carboxyamidealkyl, phospho alkyl, alkyl sulfoxide, alkyl sulfone, alkyl sulfide, haloalkyl, aryl, N-oxide, dialkylamino, carbamate, or arylsulfonyl.
- 30 2. The compound of Claim 1 wherein n is 4 and p = q = r = s = 0.

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- 3. The compound of Claim 1 wherein at least two R substituents are coupled to form a bridged structure, the two R substituents selected from the group consisting of an odd numbered R substituent and a pyrrole R substituent, and when coupled to form a bridged structure, nonbridged substituents are as defined.
- 4. A compound comprising a β-substituted calix[n]pyrrole macrocycle having structure I:

wherein

- n is 4; p=q=r=s=0, even numbered R substituents are fluoro, odd numbered R substituents are alkyl, and  $R_A$   $R_D$  are hydrogen.
- 5. A composition comprising the compound of Claim 1 incorporated into a polymer matrix.

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- 6. A composition comprising the compound of Claim 1 incorporated into a membrane.
- 7. A composition comprising the compound of Claim 1 incorporated into a liposome.
- 8. A compound comprising a fluorinated calix[n]pyrrole where n is 9, 10, 11, or 12.
- 9. The compound of Claim 1 wherein n is 5.
- 10 10. The compound of Claim 1 wherein n is 6 or 7.
  - 11. The compound of Claim 1 wherein n is 8.
  - 12. A method of making a halogenated calix[n]pyrrole where n is 4, 5, 6, 7, 8, 9, 10, 11, or 12 comprising

reacting 3,4-dihalopyrrole and a ketone molecule for a time sufficient to produce the halogenated calix[n]pyrrole.

- 13. The method of Claim 12 wherein the halogenated calix[n]pyrrole is a fluorinated calix[n]pyrrole and the 3,4-dihalopyrrole is a 3,4-difluoropyrrole.
- 14. A method of removing an anion from an environment containing the anion comprising contacting the environment with a halogenated calix[n]pyrrole where n is 4, 5, 6, 7, or 8 wherein the halogenated calix[n]pyrrole binds the anion thereby removing the anion from the environment.
- 15. The method of Claim 14 wherein the anion is an environmental pollutant.
- 16. The method of Claim 14 wherein the anion is fluoride, chloride, or phosphate.
- The method of Claim 14 wherein the anion is pertechnetate.
  - 18. A method for extracting an ion pair having a cation associated with an anion from an environment containing said ion pair, the method comprising contacting the environment with an

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anion coextractant and a cation coextractant, wherein the anion coextractant is a calix[n]pyrrole where n is 4, 5, 6, 7, or 8, and wherein the calix[n]pyrrole binds the anion and the cation coextractant binds the cation thereby allowing for removal of the ion pair from the environment.

- 19. The method of Claim 18 wherein the calix[n]pyrrole is a halogenated calix[n]pyrrole.
- 20. The method of Claim 18 wherein the calix[n]pyrrole is a fluorinated calix[n]pyrrole.
- 10 21. The method of Claim 18 wherein the ion pair is an environmental pollutant.
  - 22. The method of Claim 18 wherein the cation coextractant is a crown ether, a cryptand, a calixarene, a calixarene-crown ether cryptand, or a calixarene-crown ether conjugate.
  - 23. The method of Claim 18 wherein the cation coextractant is a cation exchanger.
  - A method for reducing or preventing corrosion on a substrate susceptible to corrosion in the presence of a corrosion-promoting anion, comprising contacting the substrate with a calix[n]pyrrole where n is 4, 5, 6, 7, or 8 wherein the calix[n]pyrrole binds the corrosion-promoting anion, thereby reducing or preventing corrosion of the substrate.
  - 25. The method of Claim 24 wherein the calix[n]pyrrole is a halogenated calix[n]pyrrole.
  - 26. The method of Claim 24 wherein the calix[n]pyrrole is a fluorinated calix[n]pyrrole.
  - 27. The method of Claim 24 wherein the substrate is gasoline or jet fuel and the anion is a chloride anion.
- 28. A method for producing a naked cation in a solution containing said cation paired with an anion, the method comprising contacting a calix[n]pyrrole where n is 4, 5, 6, 7, or 8 with the solution, wherein the calix[n]pyrrole binds the anion thereby providing the naked cation.
  - 29. The method of Claim 18 wherein the cation is cesium.

30. A compound selected from the group consisting of compounds 44, 46, 48, 50, and 52.